

# Three-telescope synchronized narrowband pulse observations

Green Bank, Haswell, and New Hampshire  
radio telescopes

Observations: December 2019

Preliminary report

Skip Crilly  
Education and Public Outreach  
Volunteer Science Ambassador  
Green Bank Observatory  
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## Abstract

### August 2019 report

Radio Frequency Interference (RFI) is a confounding problem in radio SETI, as false positives are introduced into receiver signals. Various methods exist to attempt to excise suspected RFI, with a possibility that true positives are rejected, and that un-excised RFI remain as false positives. Uncertain far side-lobe antenna patterns add to the uncertainty. To ameliorate the RFI problem, a system having geographically-spaced simultaneous and synchronized pulse reception has been implemented. A radio telescope at the Green Bank Observatory in Green Bank, West Virginia has been combined with a radio telescope of the Deep Space Exploration Society, near Haswell, Colorado to implement a spatial filter having a thrice-Moon-distance transmitter rejection. Approximately 135 hours of simultaneous synchronized pulse observations have been captured from November 2017 through February 2019 and another 45 hours captured in April 2019. The observations are described in a paper presented August 4, 2019 at the annual conference of the Society of Amateur Radio Astronomers at the Green Bank Observatory. The August 2019 paper describes the problem, observation system, observed results and proposed hypotheses to be subjected to attempts at refutation and relative inference, through further experimentation, and RFI and ETI transmitter signal model development. The paper describes anomalous simultaneous pulses observed in the pointing direction of HIP 24472, near 5.2 hours RA and  $-7.6^\circ$  declination.

### **January 2020 Update**

The report contained in this present paper describes additional observations, made in December 2019, using a third telescope added to the synchronized telescope system. The third telescope is a 26 foot diameter antenna in New Hampshire. A GPS receiver is used to synchronize New Hampshire frequency and acquisition time to those of the telescopes in Green Bank and Haswell. The purpose of this report is not to exhaustively describe the December observations. Rather, the intent is to report preliminary post processed results.

## Geographically-spaced Synchronized Signal Detection System

Transit scan observations  
using overlapping antenna beams

GPS time and frequency is synchronized.  
Receivers: 1395-1455 MHz 3.7 Hz  $\Delta f$  channels



New Hampshire  
26 foot



Haswell, Colorado 60 foot

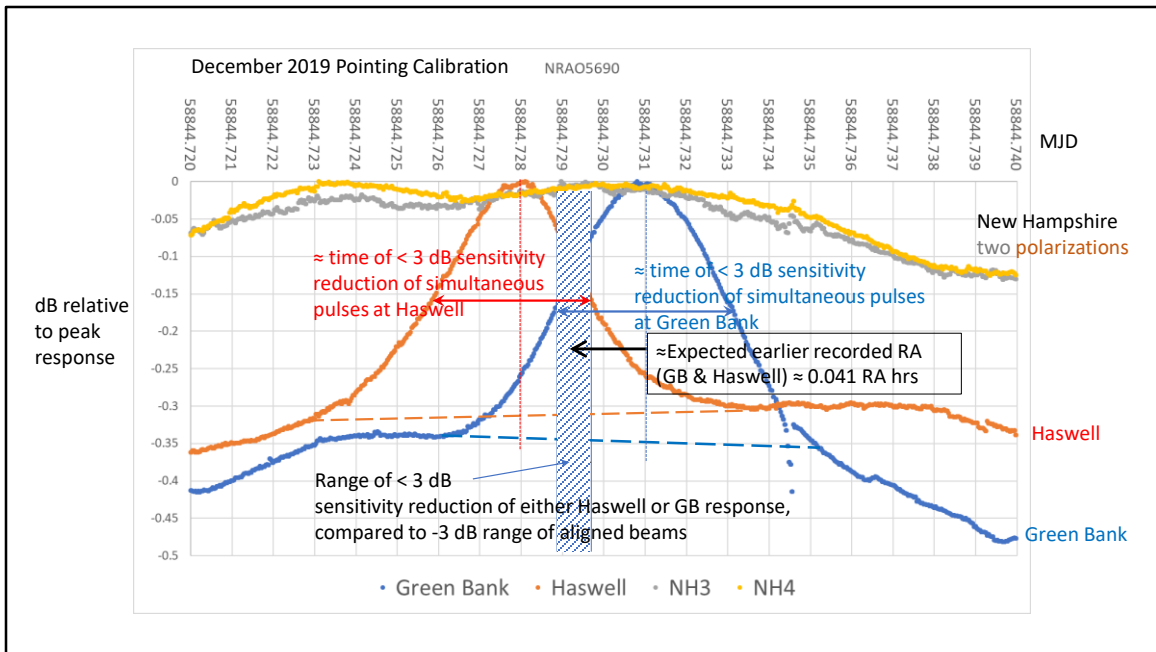


Green Bank, West Virginia 40 foot

### Geographically-spaced Synchronized Signal Detection System

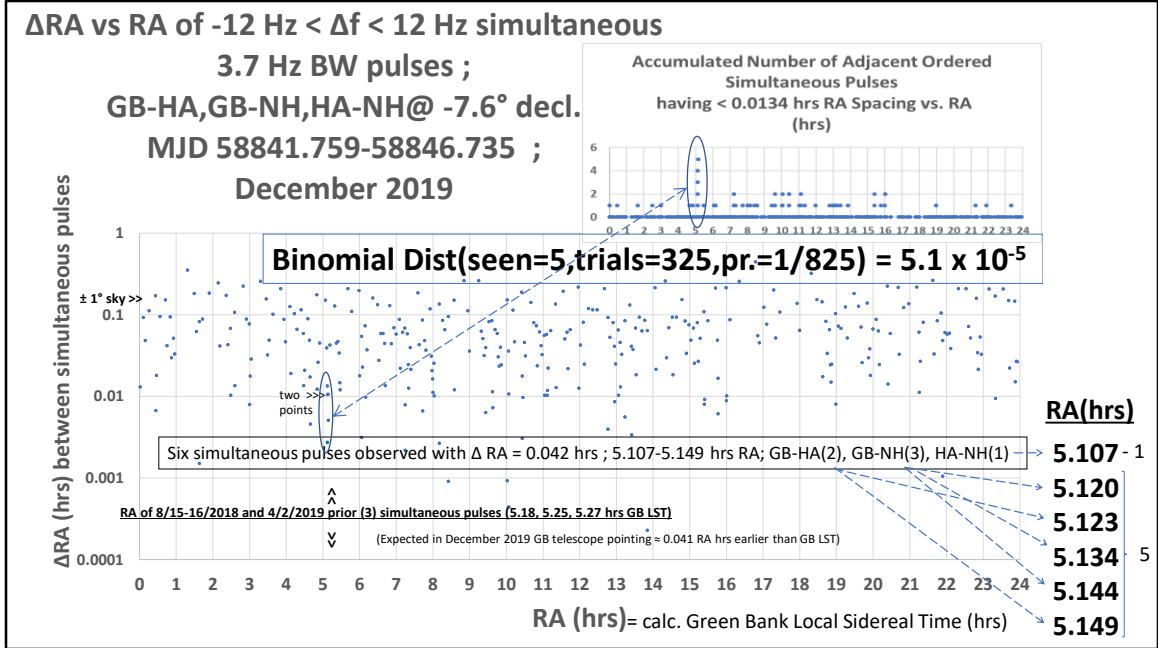
The synchronized telescope system comprises three telescopes. The New Hampshire telescope has orthogonal circular polarization receivers, Haswell has one circular polarization receiver, Green Bank has one linear polarized receiver. The telescopes operate independently during observations, i.e. are not networked and are not communicating with one another. The GPS satellite constellation synchronizes frequency and time. Narrow bandwidth pulse measurement files are captured and post processed after observation runs are complete. Details of signal processing and RFI excision are included in the August 2019 SARA Green Bank paper, in the references section of this report.

Automatic RFI excision has been added in December 2019 processing. 1 kHz bandwidth spectrum segments having an anomalous large number of bin hits are suspected to be RFI, and are excluded from post processing. Spectrum segments that contain the number of bin hits expected in noise are used to search in post processing for simultaneous pulses.



## Calibration of telescope pointing

Astronomical object NRAO 5690 is observed to calibrate the pointing of the three telescopes. An apparent azimuth offset of the Haswell telescope was observed. This offset reduces the peak sensitivity of the detection of simultaneous pulses at Haswell and Green Bank, while not significantly affecting simultaneous pulses at New Hampshire and either Haswell or Green Bank. The peak sensitivity of simultaneous detection using the Haswell & Green Bank telescope pair is moved to a Right Ascension pointing earlier in time than without the pointing offset. Simultaneous pulses are searched, from raw telescope data, using software that posts the Local Sidereal Time of the Green Bank Forty Foot Telescope, pointing to an azimuth of 180 degrees. This post processing data post estimates the Right Ascension of an object hypothetically in the center of the Green Bank antenna beam-width. Given the Haswell pointing offset to the east, the estimated Right Ascension of an object in both Haswell and Green Bank beams increases by approximately 0.041 hours of RA, relative to the RA value set by the LST of Green Bank at the time of the observation.



**Additional anomalous simultaneous pulses are observed near the HIP 24472 pointing direction**

Six anomalous simultaneous pulses were observed in the approximate HIP 24472 pointing direction, among 325 candidate simultaneous pulses observed during the December 2019 observation run. These six pulses add to the three anomalous Green Bank-Haswell pulses observed in the previous observations, i.e. in August 2018 and April 2019. The binomial distribution noise likelihood of the cumulative RA span of the December 2019 six pulses calculates to a mean of five expected events in 10,000 experiments. An experiment under this analysis is defined as a multi-day transit observation, e.g. as performed in December 2019. The five pulses following the first pulse at 5.107 hrs RA, ordered in RA, have a binomial distribution noise likelihood of presence in one of 825 RA bins at 5.1 in 100,000 tries of multi-day assays, each having 325 simultaneous pulses, as observed in December 2019. The 825 RA bins are established from the observed close RA spacing of the following five simultaneous pulses.

**Further work**

Additional observations will seek and refute various hypotheses, using Bayesian

Inference calculations. Two additional 30 foot antennas are under construction, planned to be operated around the clock, synchronized with the New Hampshire 26 foot antenna. One of the two antennas under construction is planned to be transported to the Pacific Northwest. Green Bank and Haswell will be added to the five antenna system when time on these two telescopes is scheduled.

**References:**

Details of the SETI project and observations are in a paper presented in August 2019, in Green Bank, West Virginia:

[http://dses.science/wp-content/uploads/2019/08/SARA\\_2019\\_GreenBank\\_Crilly\\_73\\_f.pdf](http://dses.science/wp-content/uploads/2019/08/SARA_2019_GreenBank_Crilly_73_f.pdf)

Close frequency tones observed and described in Fig. 9 of the August 2019 paper are played in the following WAV file:[http://dses.science/wp-content/uploads/2019/02/Fig\\_7\\_tones.wav](http://dses.science/wp-content/uploads/2019/02/Fig_7_tones.wav)

The Deep Space Exploration Society Publications page is:<http://dses.science/deep-space-exploration-society/dses-publications>

Thank you!

Thank you

Steve Plock

Deep Space Exploration Society team

Green Bank Observatory team

family and friends